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THE NATURE AND CAUSES OF INJURIES IN FEMALE RECRUITS RESULTING --ETC(U)
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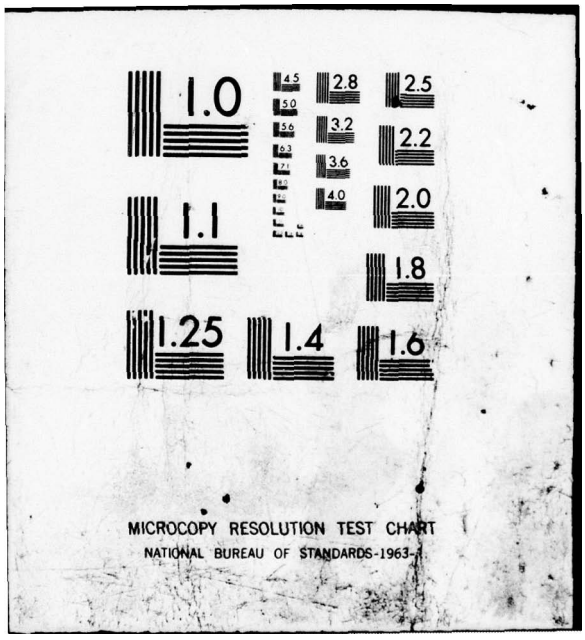
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Women entering the Army are exposed to considerable physical stress due to the intense physical training program encountered. Four hundred women recruits, aged 18-29, participated in a prospective study to (1) determine the incidence and nature of injuries they would sustain as the result of a vigorous, supervised training program and (2) identify the predisposing factors that may be related to their occurrence. The data demonstrated that 54% (215) women sustained reportable injuries resulted in an average training time loss of 13 days.

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Fouty-one percent of these injuries resulted in major profiles and limited all participation in physical training. Significant injuries were: tibial stress fractures in 45, chrondomalacia of the patella (CMP) in 21, hip or neck of the femur stress fractures in 20, sprains in 12, achilles tendonitis in 10 calcaneous, metatarsal stress fractures in 8, and fascial or anterior compartment strains in 6. The injury data were correlated with prior fitness measures, documenting that a major cause of injury in women can be attributed to the lack of conditioning, greater body weight and body fat and limited leg strength. It was concluded that susceptibility to these potential orthopedic and medical conditions could be identified prior to beginning training and minimized through proper screening and remedial action prior to initiating a vigorous physical training program.

THE NATURE AND CAUSES OF INJURIES IN FEMALE RECRUITS RESULTING FROM AN 8-WEEK PHYSICAL TRAINING PROGRAM

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ABSTRACT

Women entering the Army are exposed to considerable physical stress due to the intense physical training program encountered. Four hundred women recruits, aged 18-29, participated in a prospective study to 1) determine the incidence and nature of injuries they would sustain as the result of a vigorous, supervised training program and 2) identify the predisposing factors that may be related to their occurrence. The data demonstrated that 54% (215) women sustained reportable injuries that resulted in an average training time loss of 13 days. Forty-one percent of these injuries resulted in major profiles and limited all participation in physical training. Significant injuries were: tibial stress fractures in 45, chrondromalacia of the patella (CMP) in 21, hip or neck of the femur stress fractures in 20, sprains in 12, achilles tendonitis in 10 calcaneous, metatarsal stress fractures in 8, and fascial or anterior compartment strains in 6. The injury data were correlated with prior fitness measures, documenting that a major cause of injury in women can be attributed to the lack of conditioning, greater body weight and body fat and limited leg strength. It was concluded that susceptibility to these potential orthopedic and medical conditions could be identified prior to beginning training and minimized through proper screening and remedial action prior to initiating a vigorous physical training program.

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Women entering the Army are exposed to considerable physical stress due to the intense physical training program encountered. At the beginning of a basic training cycle a prospective study was initiated to identify exercise related injuries and performance-limiting conditions that resulted from an 8-week PT program and to identify some of the factors that may contribute to their occurrence. Four hundred women recruits, aged 18-29, participated in the study. All had passed an initial physical examination and were without any limiting disabilities. An initial assessment of physical fitness was accomplished to determine the current status of body composition, strength of the major muscle groups,(e.g., legs, trunk, arms and upper torso), aerobic capacity, previous athletic history, self perception of physical fitness, and psychosomatic predisposition. The training and conditioning program consisted of 1hr/day, 5-6 times a week and involved a series of standard warm up calisthenics and stretching exercises followed by a run, beginning at 3/4 mile at a 10 min/mile pace and increasing to 2 miles at 9-1/2 min/mile by the end of training. Extensive road marches and military training activities were also included. At the end of training a self report injury questionnaire was used to collect injury data. These data were documented with the records from the unit dispensary and data provided by the installation physical therapy, orthopedic, and

podiatry clinics. Fifty-four percent (215) of the women sustained some reportable injury. These injuries resulted in an average training time loss of 13 days. Forty-one percent of these injuries prevented participation in all activity, 31% resulted in only limited participation. Early training "overuse syndrome" accounted for 42% (92) of the reported injuries. Significant injuries were: tibial stress fracture in 45, condromalacia of the patella (CMP) in 21, hip or neck of femur stress fracture in 20, sprains in 12, achilles tendonitis in 10, calcaneous, metatarsal stress fracture in 8, and fascial and anterior compartment strains in 6. The injury data were correlated with prior-fitness measures, documenting that a major cause of injury in women can be attributed to the lack of prior conditioning, greater body weight and fat percent, and limited leg strength. These factors, coupled with some inherent physiological characteristics of women, (i.e. wide pelvis, less strength and greater joint flexibility), contributed to the increased risk of injury in these women. It is concluded that susceptibility to these potential orthopedic and medical conditions can be identified prior to the beginning of training and minimized through proper remedial actions before a strenuous PT program is initiated.

With the rising recruitment of women into the armed forces, data are needed on the response of women to physical training and the physical differences that may limit their performance capacity. Although insights have been gained regarding the beneficial effects of physical training on the stamina, muscular strength, and endurance of both men and women in the armed forces [1,2,3] little information is available concerning the risk of injury involved in exposing previously sedentary women to a rigorous physical training program.

In the past, it has been extremely difficult to study the incidence and distribution of injuries in normal young women because of the relatively small number participating in strenuous physical activity and the self-selected nature (athletes) of those who do [4,5,6,7]. However, this has changed with the rising interest and participation of women in the whole spectrum of sport activities. The purpose of this prospective research was to 1) determine the incidence and nature of injuries in a female population as a result of a rigorous, supervised training program and 2) identify the predisposing factors that may be related to their occurrence.

METHODS

We followed a group of 400 women recruits, aged 18-29 years old (average age 21) through a complete 8 week basic training cycle (January 15 through March 12, 1978). (See Table 3 for other descriptive characteristics.) A complete medical history was available, and they were given a complete physical examination prior to the beginning of training. Prior to training, an initial assessment of physical fitness was accomplished. This assessment included the determination of body composition,[8] strength of the major muscle groups, (eg. legs, trunk, arms and upper

torso), aerobic capacity (VO_2 max)[9], psychosomatic predisposition using the Health Opinion Survey (HOS),[10] activity history (previous athletic participation), and self-perception of fitness level compared to other women of comparable age prior to beginning training.

These women participated in an integrated (male and female) training and conditioning program 1 hour per day, 5-6 times a week that involved a series of standard warm-up calisthenics including situps, pushups, side straddle hop, leg overs, and modified knee bends. These exercises preceded each training session and progressed from 6 to 12 repetitions per session over the course of the training program. Running began with 3/4 miles a day at a 10 min/mile pace and increased to 2 miles in 18:30 minutes by the end of the 8 week training period. The training program also involved extensive marching and other activities germane to military training.*

For the purposes of this study, an injury was defined as any disability which was incurred during, or as a result of, physical training/conditioning which required attention from the medical facility. Only 327 of the 400 women were available for post training evaluation; 20 additional women were subsequently followed up because they had sustained injuries which required hospitalization. The remaining 53 women were administratively discharged or unavailable for testing, and no information was available on them.

The injury data were gathered through the use of a self report medical disposition questionnaire given to the women following training. These data were supplemented with records from the dispensary and data provided by the installation physical therapy, orthopedic, and podiatry clinics.

A discriminant function analysis was performed using injury during training as

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*The training program is outlined in the Drill Sergeant Guide for Pre-Baseline Physical Training. Fort Benning, GA, dtd, 20 Dec 77.

the criterion variable and using the variables gathered during initial assessment as predictors.

RESULTS

The self report questionnaire data indicated that 54% (215 of 347) of the women had sustained some sort of injury requiring medical attention over the 8 weeks of training. The incidence as tabulated from the questionnaire is presented in Table 1. (It should be noted that the incidence of injury in women compared unfavorably with the incidence reported for men undergoing the same training (26% or 202 of 770). These injuries resulted in an average loss of 13 training days during the basic training cycle, 41% (80) of the injuries prevented participation in all physical activity (major profile) and 31% (61) resulted in limited participation (minor profile). Table 2 presents a summary of the specific diagnoses and structural involvement of these injuries as documented by the hospital consultation sheets.

Injuries usually resulted from a combination of (1) continued hard training after onset of symptoms, (2) inherent structural weakness, or (3) biomechanical anomaly. It should be noted that tibial and femoral stress fractures accounted for a third of all the injuries identified and represented the most serious sequale of this physical training. Figure 2 presents stress fracture data as a function of the onset of symptoms during the 8 week training cycle. The incidence of tibial stress fractures increased during February, and dropped off in March. The hip stress fractures increased throughout training and reached the maximum during the last two weeks of training.

Body composition, muscular strength of the legs, predicted VO_2 max, previous athletic participation, self perception of fitness and psychosomatic

predisposition were correlated with injury (Table 3). The discriminant analysis resulted in a linear combination of the measured variables that maximally differentiated the two groups. For the present data, the discriminant function is .507 PHY FIT + .683 WT - .662 LEGSTR -.552 PCFAT. However, only 55% of the cases could be correctly classified. Table 4 presents a breakdown of the different degree of injury (major, minor, overuse) within the group of injured women. As can be seen, the variables of PCFAT and LEGSTR are both significantly different across the group and corresponds to the previous findings between injured and uninjured women.

DISCUSSION

The data presented document that weight, % body fat, and limited leg strength in women can be attributed to lack of prior fitness or conditioning. These findings also suggest that these factors may be responsible for the increased incidence of injuries occurring in women during training, and any reduction in this incidence is seen as cost effective. Likewise, there are several physiological factors reported in the literature[12] which are generally considered to predispose women to these injuries. The elasticity in the connective tissue, which causes women to be more flexible, may make them more vulnerable to ligament or joint injury. Women's biomechanics and wide pelvis appear to contribute to the increased risk of injury to the hip and outer aspect of knee, leg and foot because of the varus tilt. This is further aggravated by the apparent lack of heel stability inherent in the Army boot used by the women during basic training. Though the standard Army boot has proved quite satisfactory for men during basic training, women report that the heal width is too great even in the narrow sizes used by women. The resulting heal instability surely aggrevates existent ankle weakness or

foot disorder. Likewise, since women are of smaller structure, the 30" step, the very basis of the military drill and ceremony, is often an aggravating factor in the incidence of stress fractures and overuse syndromes. Another factor contributing to injuries in women may be their inability to differentiate between "pushing themselves" beyond the pain threshold and exposing themselves to undue risk of injury. It is evident from the data that many of the symptoms of overuse which occurred early in the training program culminated in injury later on, having been neglected or considered inconsequential initially. Likewise, returning to training before the symptoms had fully disappeared was courting diaster later in training.

A major factor in the development of injuries in this sample is believed to be the rapid onset of training which did not allow for a progressive exposure to stress and the development of tolerance. The more sedentary, unconditioned women were exposed to a greater risk of injury to the lower extremeties when they were put under this physical stress. Initially, the bones attempt to become stronger by remodeling their internal architecture in response to the chronic physical demand. In doing so, they actually become weaker in the area of mechanical stress, and continued training during this period may have lead to injury. The second phase of this remodeling involves actual desposition and hypertrophy of the bone along the lines of stress. However, during the lag time between these two phases, the bone is also more susceptible to fracture[13]. If training had been more progressive some of these injuries might have been avoided.

Stress fractures have been widely studied in men,[7] because they can potentially prevent an individual from performing his normal duties for a prolonged period of time. However, with the increasing number of women participating in various physical activities, the occurrence of stress fracture has risen

dramatically[6]. With regard to the causes of stress fractures, the results of Gilbert and Johnson[11] apply equally well to women as to men. The stress fractures are related to body structure and are found to be more common among overweight recruits and those with little exercise experience. However, the majority of the fractures reported by Gilbert and Johnson were of the metatarsals and os calcis, whereas in the present study we found only 8 cases of these types of stress fractures. The majority of those found in women recruits were tibial and femoral in nature, as well as a large number of knee injuries.

Though the conventional statistical criterion for significance was not achieved, it must be kept in mind that in this case the increased probability of a Type I error ($P \geq .15$) still provides for a substantial improvement over no information at all regarding an individual's susceptbility to injury.

CONCLUSION

According to our finding, women tend to have more injuries when they enter an intense training program and these injuries are more severe in nature than those reported for men. The factors that contribute to this increased probability of injury include a lack of physical conditioning prior to entering the program, greater body weight, less leg strength and greater percent body fat than women who did not sustain injuries during the prgram. However, several other factors also appear to be predisposing factors for injuries in women.

Many women are inexperienced in intense exercise and do not understand "pushing themselves" as a method of developing tolerance (especially earlier in the training cycle); this inexperience may be associated with the risk of subsequent injury. If the training were more progressive, many initial injuries could be

avoided. Remedial exercises for the development of lower leg strength and joint stability could also prove to be of value in reducing injury from the clinical standpoint. Likewise, heel orthotics inserted in the boots may reduce injury by stabilizing the foot during running. Probably most important, however, is that personnel must be aware of the signs and symptoms of overuse syndrome and the complication of an untreated stress fracture especially in the femur or its neck.

Based on the results presented above, there can be little doubt that disorders of the lower extremities for the female recruit in the military are costly in terms of medical care and utilization, recruit training time lost, hospitalization and other duty restriction. Actually, the solution to the problem is not clear cut because of the multidimensional nature of the problem. Preventative programs such as thorough pre-enlistment screening, that include an assessment of the factors discussed in this paper eg. prior physical activity, leg strength, body composition and weight, would provide a means of identifying individuals at risk of injury and allow for appropriate action. These could be in the form of remedial physical training and toughening programs, orthotics, and proper breaking in of footwear. Likewise early identification and treatment of overuse symptoms would be necessary to further reduce the incidence of lower extremity injuries in all recruits entering training, but especially in women because of their increased susceptibility to injury.

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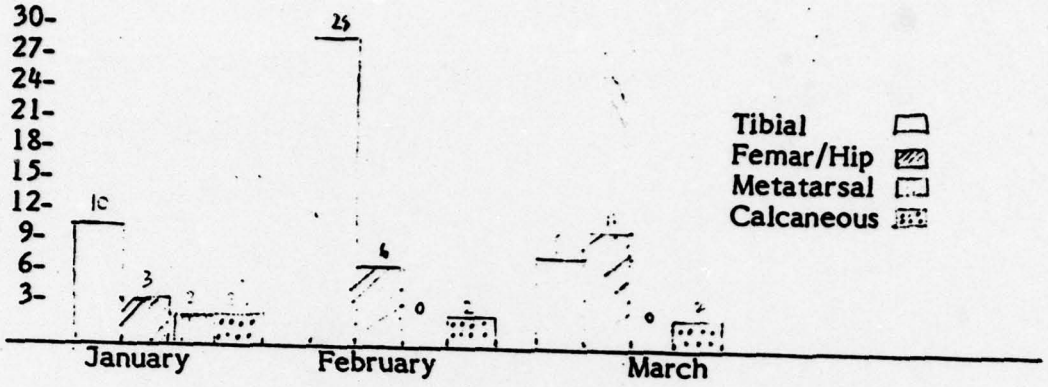
Figure 1

Stress Fracture and the Onset of Symptoms
during Basic Training



TIME PERIOD

Table 1

Self Report of the Incidence of Injuries Sustained by men and women during Basic Training

	WOMEN (215)		MEN (202)		% DIFF (W-M)
Type of Injury	N	%	N	%	
Fracture (Break)	8	3	4	2	1
Stress Fracture	45	21	9	4	17
Joint Problems	30	14	47	24	-10
Foot Problems	28	12	54	27	-15
Tendon Inflamations	67	31	23	12	19
Muscle Strain	27	12	26	13	- 1
Other	10	4	39	20	-16

Table 2

Dignosed Injury Sustained by Women during Basic Training (N=215)

Structure	N	%
Overuse Syndrome = (leg soreness, lowered general energy level, clumsiness and poor coordination)	92	42
Tibial Stress FX	45	21
Chondromalatia of Patella	21	9
Hip or Neck of Femur Stress FX	20	9
Ankle Sprain	12	6
Achilles Tendonitus	10	4
Calcaneous Stress FX	6	3
Anterior Compartment & Fascial Strain	6	3
Metatarsal Stress FX	2	1

Table 3

Comparison of Selected Parameters for Injured vs Uninjured Women Prior to Participation in 8 Weeks of Physical Training

Variables	Injured N=195	Uninjured N=132
Body weight (kg) WT	59.2 ± 7.3	59.3 ± 6.8
Height (cm) HT	162.3 ± 6.8	162.5 ± 6.3
Body fat (%) PCFAT	28.4 ± 4.9	27.7 ± 4.4
Static strength of leg extensors LEGSTR (kg of force)	91.2 ± 32	95.7 ± 28
VO_2 max (Ml/kg min) VO_2	37.9 ± 4.6	36.2 ± 3.3
Previous athletic participation (1 very inactive - 5 very active) ATHPAR	3.18 ± .9	3.25 ± .8
Physical fitness compared to other women (1 poor to -5 superior) PHYFIT	2.82 ± .7	2.90 ± .5
HOS score (psychosomatic predisposition) HOS	31.3 ± 6.6	30.3 ± 5.5

DISCRIMINANT ANALYSIS

SUMMARY TABLE

STEP NUMBER	VARIABLE ENTERED	APPROX F	RAO'S V	DF	SIGN LEV
1	PHY FIT	2.56	2.56	1/295	.10
2	LEGSTR	1.97	3.97	2/294	.13
3	WT	1.55	4.70	3/293	.19
4	PCFAT	1.67	6.74	4/292	.15

CLASSIFICATION MATRIX

		PREDICTED GROUP INJURED	UNINJURED
ACTUAL GROUP	N		
INJURED	195	52.9	47.1
UNINJURED	132	41.1	58.9

PERCENT OF CASES CORRECTLY CLASSIFIED 55.16%

Table 4

Comparison of Pretraining Parameters for the Levels of Injury Sustained by Women during 8 Weeks of Physical Training (N=215)

Variables	Major Injury N=80	Minor Injury N=66	Overuse Syndrome N=64
Body weight (kg)	59.7 ± 7.4	58.0 ± 6.9	59.8 ± 7.6
Height (cm)	162.1 ± 6.9	161.3 ± 6.7	163.6 ± 6.9
Body fat (%)	29.5 ± 4.4	28.3 ± 5.3	27.4 ± 4.9
Static strength of leg extensors (kg of force)	93.5 ± 3.2	92.9 ± 3.2	103.1 ± 3.3
VO_2 max (Ml/kg min) VO_2 max	38.4 ± 4.2	36.7 ± 4.1	39.2 ± 3.6
Previous athletic participation (1 very inactive - 5 very active)	3.18 ± .7	3.19 ± .9	3.20 ± .8
Physical fitness compared to other women (1 poor to 5 superior)	1.85 ± .5	1.91 ± .4	2.10 ± .5
HOS score (psychosomatic predisposition)	30.9 ± 6.7	31.6 ± 6.4	31.3 ± 6.7

*$p \leq .05$

1. The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation.

2. Human subjects participated in these studies after giving their free and informed voluntary consent. Investigators adhered to AR 70-25 and USAMRDC Regulation 70-25 on Use of Volunteers in Research.